THE WEATHER OF THE GREAT TILLAMOOK, OREG., FIRE OF AUGUST 1933

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(Graphic presentation prepared by William G. Morris, junior forester, Pacific Northwest Forest Experiment Station)

One of the largest and most devastating forest fires ever known in Oregon, now referred to as the "Great Tillamook Fire", occurred in the northwestern part of the State the latter part of August 1933, starting on the 14th and reaching its climax on the 26th. According to Lynn F. Cronemiller, Oregon State forester, the Tillamook fire will go down in history as one of the greatest in the United States from the standpoint of timber loss and it undoubtedly was the greatest forest fire ever fought in the Northwest. Low relative humidities, fresh to strong easterly winds, and high temperatures were responsible for this huge fire which started from a tiny spark caused by the friction of one log being dragged across another on an active logging operation at a time when weather conditions were just right for a blow-up. Although the logging crew on the operation where the fire started made immediate efforts to extinguish the flames, the fire nevertheless was soon out of control, crowned through nearby timber and raced up the hillside. In fact, the crew was getting ready to quit for the day on account of the bad fire-weather conditions when the fire broke out; a number of the crew were already on their way to camp. Estimates by the Pacific Northwest Forest Experiment Station place the burned over area at 261,640 acres, of which 185,038 acres represent virgin timber lands, 54,955 acres second growth, and the remainder old burns and cut-over lands. The experiment station estimates that 10,968,819,000 board feet of standing timber was burned or damaged.

Another large fire, the Wolf Creek fire, started about 4 p.m. on August 24 in 300 acres of 3-year slashings about 10 miles north of where the Tillamook fire started on August 14. By midnight of the 25th, this fire had run a distance of 11 miles from where it started. Change of wind direction on the afternoon of the 26th from easterly to westerly caused the fire to reverse its direction of travel, burning back over itself and burning up a large logging camp that had previously been saved. The Wolf Creek fire burned over an area of 43,115 acres, of which 26,000 acres represent virgin timber lands of the finest type, 7,000 acres of timber lands with trees about 20 inches in diameter, and the rest old burns and cut-over lands. The Pacific Northwest Forest Experiment Station estimates the fire killed nearly 1,500,000,000 board feet of timber. This was a large forest fire, but in great measure was lost sight of at the time by the public in general because of the major proportions assumed by the Tillamook fire.

The low relative humidities, fresh to strong easterly winds and high temperatures result from the slow progressive eastward movement of high-pressure areas over the northern plateau and Rocky Mountain regions. As these high-pressure areas move east and southeastward, the normally low-pressure trough over the interior of California of the summer months usually builds northward over the western portions of Oregon and Washington into British Columbia and Alaska, also off the adjacent coasts, bringing about a steeper barometric gradient to increase the strength of these easterly winds at such times over the Pacific Northwest. These are the pressure conditions that prevailed during the bad fire-weather periods of August 10 to 16, and August 21 to 26. Pressure gradients were somewhat weaker, however, during the first period than during the second when the worst fire-weather conditions prevailed. The center of high pressure also moved in farther south over Western Canada during the second period than during the first, particularly on August 25 and 26, when the worst fire-weather conditions prevailed and the fire made its largest run and did its greatest damage.

Since this article is dealing with weather and its relation to the great Tillamook fire, discussion is being confined largely to the weather which prevailed at the time over northwestern Oregon, particularly over the northern Coast Range where the fire occurred. Figure 1 is a map of northwestern Oregon showing the location of the fire, where it started, the approximate area burned over and the fire-weather stations nearest the scene of the fire. This map also shows the location of the Wolf Creek fire, where it started and its proportional size as compared with the much larger Tillamook fire.

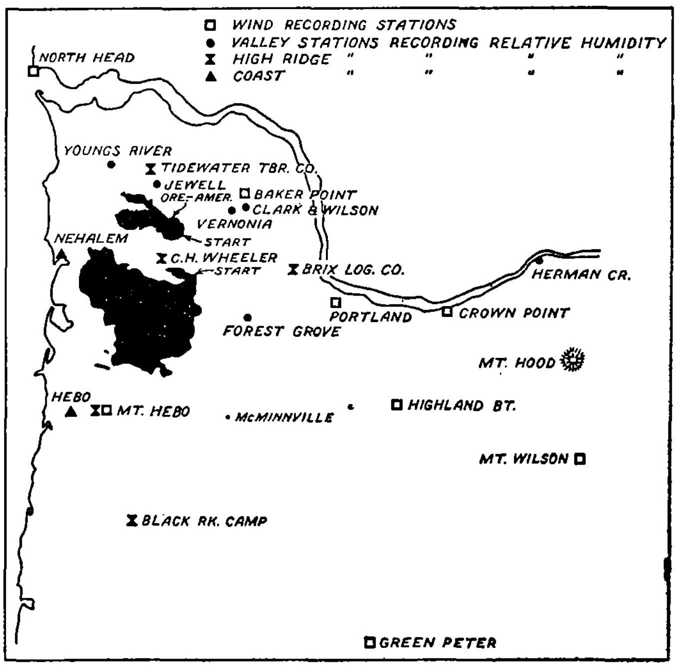

FIGURE 1.—Northwestern Oregon—location of fire, where it started, area covered, and nearest fire-weather stations.

Relative humidities were generally low, 35 percent and lower, from August 10 to 16 at the lower interior stations, but for a somewhat longer time at the higher levels on the ridges. They were low again from August 21 to 26, this latter period producing lower humidities of longer duration and being by far the worst of the two periods. As regards relative humidity, the worst fire-weather days were as follows:

(*a*) Coast stations, ranging in elevation from 40 to 80 feet: Low humidities on August 14, 21–22, and 25, extending well into the night of the 25–26th. There was considerable recovery of relative humidity near the coast on the 23d, 24th, and 26th. (See fig. 3.)

(*b*) Valley stations, ranging in elevation from 70 to 750 feet: Low humidities on the 10th to 16th, the worst fire-weather conditions prevailing on the 14th and 15th. Humidities low again from the 21st to the 26th, the worst days being the 25th and 26th, not only for this critical period but also for the whole time the fire was active. Relative humidities were quite low in the daytime but made considerable or complete recovery at night. (See fig. 3.)

(c) High ridge stations, ranging in elevation from 1,140 to 3,153 feet: Humidities generally low from the 10th to the 17th, and again from the 21st to the 26th. Humidities quite low all night of the 14-15th, the 22-23d and the 25-26th. Highest relative humidity at Mount Hebo lookout during the entire period of the 21st to the 26th was 50 percent. Highest relative humidities the night of the 25-26th were as follows: Mount Hebo lookout, 26 percent; Cochran (C. H. Wheeler Camp No. 9), 31 percent; Tidewater Timber Co., 33 percent; and Black Rock Camp (Willamette Valley Lumber Co.), 39 percent. (See fig. 3).

(d) Lower Columbia River: Low relative humidities prevailed on the 12th, 14th, 21st, and 22d, and 25th and 26th.

(e) Columbia River Gorge: Low relative humidities prevailed on the 15th and 16th, and again from the 21st to the 26th, the worst coast stations again on the 25th, continuing low well into the ensuing night; however, they were not nearly so low as on the 21st and 22d.

Table 1 shows the departure of daily lowest relative humidity of 2-hour duration from the mean for August at the fire-weather stations nearest the Tillamook fire during the whole period the fire was most active. In general, the departures were more extreme at the high ridge stations, also at the coast stations on the worst days, than at the valley stations. Large departures, however, were experienced at all stations in the two periods when the fire spread most rapidly. The most extreme departures were at the coast stations on the 14th,

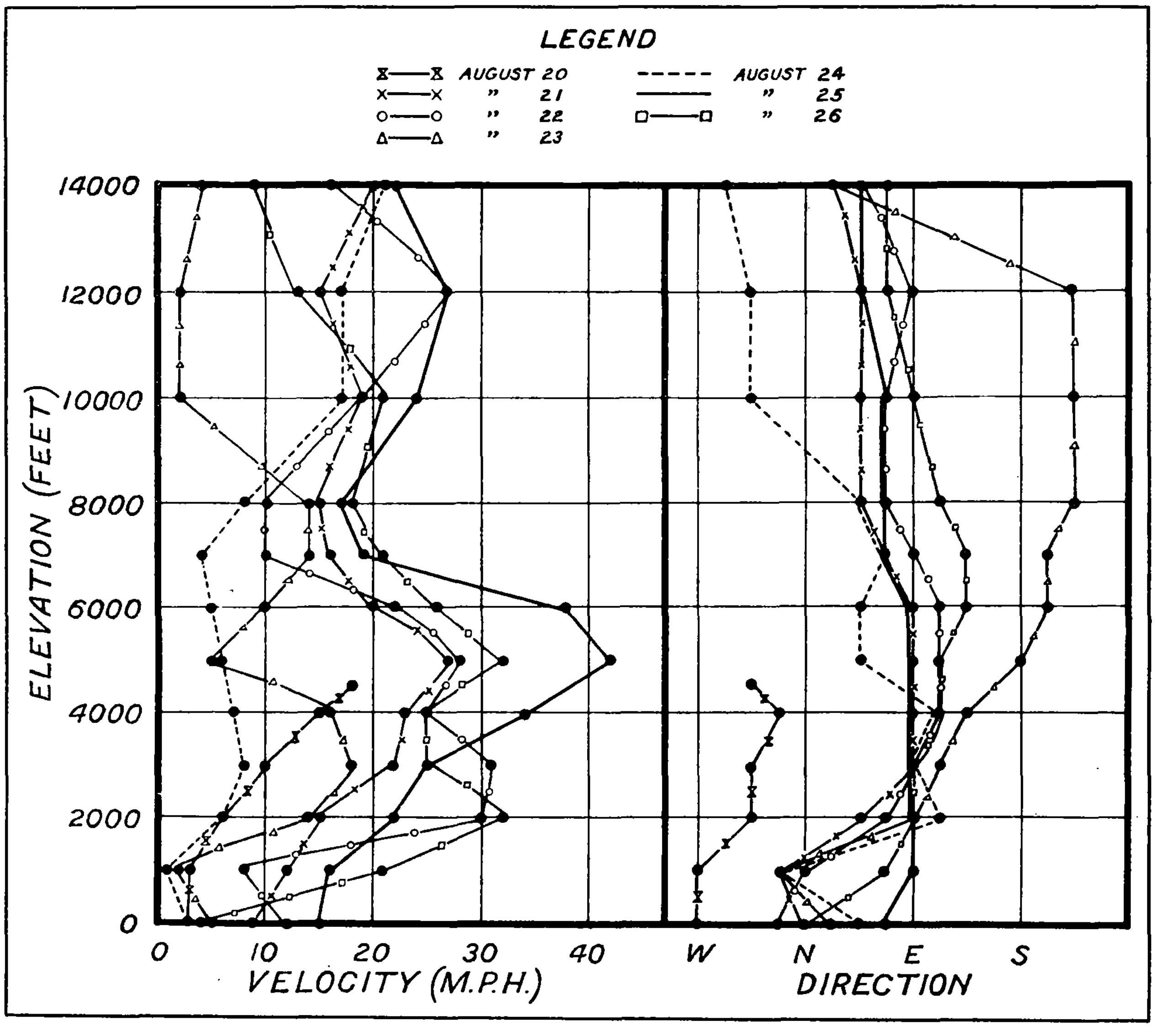

FIGURE 2.—9:30 a.m., August 20-26, 1933 pilot-balloon runs, Swan Island, Portland, Oreg.

days being the 25th and 26th. Scarcely any recovery of relative humidity on August 24 although there was some decided recovery at many of the valley and high ridge stations on this date.

Relative humidities were quite low at the valley stations in the daytime during these critical periods, but were high and made complete or almost complete recovery at night. They made much less recovery at night at the higher ridge stations, and little or none at all on the dates when the fire spread rapidly, or "blew up" entirely. Relative humidities were quite low at coast stations only on the 21st and 22d. Relative humidities were low at 21st, and 22d, and at valley and high ridge stations on the 14th, 15th, 22d, 25th, and 26th. The relative humidities were above the average, in general, during the period of August 17 to 20, when the fire was quiet and spread very slowly. The total number of hours the relative humidity was 35 percent, and lower, at each station for each of the two periods, is also given in this table.

The low relative humidities of these two critical fire-weather periods, as in all critical fire-weather periods of western Oregon, are largely the result of winds from the north and east with force considerably above normal. The normal prevailing wind direction during the fire-weather season in the northern Coast Range is from north and northwest with a relative humidity that is normally high at night and moderately high in the daytime. Easterly winds are of only occasional occurrence during the summer months over the northern Coast Range but, coming from warmer, continental areas, are warm, dry, desiccating winds that result in critical fire-weather periods with low relative humidities. The greater the force of these easterly winds, and the longer their duration, the greater the fire hazard becomes in the timbered areas.

Northerly winds, with an easterly component in the morning, prevailed over the northern Coast Range from the 10th to the 16th, except on the 15th when the wind was from the east both night and day. Easterly winds prevailed almost continuously from early in the morning of the 21st until the evening of the 26th. Most of the time in these two periods, and particularly in the latter, wind velocities were generally fresh to strong in force (19 to 38 miles an hour), probably of gale force (39 to 54 miles an hour) at times, up to elevations of about 5,000 feet, above which level they usually diminished in force for some distance in elevation before increasing in velocity again. Figure 2 is here presented to show this tendency of the wind, being a graphical presentation of the daily 9:30 a.m. pilot balloon runs taken at Swan Island Airport, Portland, Oreg., from August 20 to 26 and showing the wind direction and velocity in miles per hour from the surface to an elevation of 14,000 feet. The Columbia River Gorge is largely responsible for the increase in velocity of these easterly winds from the surface to an elevation of approximately 5,000 feet, above which level the velocity decreases materially. The Gorge acts as a funnel through the Cascade Range through which the easterly winds at such times are poured with increased force over the extreme northwest counties of Oregon where the fire occurred. Wind velocities normally increase in force with increase in elevation above the surface of the earth. Wind velocities were highest on the 14th, 15th, 21st, 22d, 25th, and 26th, being terrific the latter 2 days when the fire spread most rapidly and did the most damage.

Table 2 shows the highest wind, in miles per hour, recorded daily at a number of stations in northwestern Oregon. The location of each station with reference to the fire is shown on figure 1. North Head is near the mouth of the Columbia River on the Washington side. Baker Point, Mount Hebo, and Prairie Mountain are forest fire patrol lookouts in the northern Coast Range. Portland is in the northern end of the Willamette Valley south of the Columbia River. Highland Butte and Green Peter are association lookouts on or near the western slope of the Cascade Range while Mount Wilson is a Forest Service lookout on the summit of the Cascade Range about 20 miles south of Mount Hood. Crown Point is an airways station at the mouth of the Columbia River Gorge. With the exception of three hours after midnight at Crown Point, wind velocity records are complete for each hour at North Head, Portland, Mount Wilson, and Crown Point from midnight to midnight, while the records at each of the other stations are only during the daytime as indicated. Records at Crown Point also show the wind was from the east from 5 a.m. to 2 p.m. on the 15th, from 5 a.m. on the 21st to 1 p.m. on the 23d, and from 8 p.m. on the 24th to 10 p.m. on the 26th, also that the wind was gusty from 5 a.m. to 1 p.m. on the 25th and again from 10 a.m. to 5 p.m. on the 26th. The prevailing winds through the Columbia River Gorge are normally from the west.

Figure 3 is a graphical representation of wind velocity and direction at the two wind recording stations nearest the fire during the time it was most active. The location of these stations with reference to the fire is shown on figure 1. The legend thereon explains the graphs. Arrows representing the wind direction for each observation are shown along the top of each graph, and fly with the wind. Dots representing the wind velocity for each observation are shown near the bottom of each graph, and are connected up with solid lines to show the daily trend. Legends showing when the fire started, the days on which it spread more rapidly or more slowly, or not at all, and the final "blow-up" when the greatest damage was done, have also been placed along the bottom of figure 3. On close inspection of the humidity, wind direction and velocity it is readily seen the fire spread most rapidly and did its greatest damage when relative humidities were quite low coincident with the occurrence of fresh to strong easterly winds.

Periods of wind with considerable force, such as occurred during the time this fire was most active, are not of unusual occurrence in the Coast Range. Their most frequent directions, however, are from westerly sources with relative humidities high or moderately high so that serious conflagrations do not then occur.

Temperature is not so vital a factor in critical fire-weather periods as relative humidity and wind, being important only in its action on the relative humidity. The periods of low relative humidity are usually coincident with the periods of higher temperature. Temperatures were above normal from the 7th to the 18th, considerably above from the 10th to the 16th and decidedly above from the 13th to the 15th. Temperatures at Portland for these periods averaged 6° and 9° above normal, respectively, for the first two periods, and were 10°, 11°, and 17° above normal, respectively, on the 13th, 14th, and 15th. The maximum temperature at Portland on the 15th was 102°, being 4° higher than the former high record for the month. Temperatures were above normal again from the 21st to the 26th, averaging 8° above at Portland and being 10° above the 22nd, 25th and 26th, and 12° above on the 23d. Some other high temperature records were also established for the month at other western Oregon stations on the 15th.

The average monthly precipitation of western Oregon for August was 0.63 inch, a departure of −0.15 inch from the normal. Good rains were general over the State on the 3d and 4th. Light scattered rains occurred over the northern part of the State on the 19th, and good general rains over the western portion on the 29th and 30th.

Since the special fire-weather service of the United States Weather Bureau was started in Oregon and the Pacific Northwest late in the 1924 season, there have been four outstanding critical fire periods in western Oregon. The first of these periods occurred September 3 to 16, 1929, the second April 18 to 28, 1931, the third October 3 to 10, 1932, and the fourth that of the past season in August, from the 21st to the 26th. Similar meteorological factors—low relative humidities, fresh to strong easterly winds and high temperatures—were responsible for each of these hazardous periods. The first and third periods followed protracted dry spells and resulted in big forest fire losses. The second period was the most severe of all, as humidities were quite low and of long duration, and winds were of considerably greater intensity than in the other periods. Forest fire losses were low, however, as it followed immediately upon the heels of heavy rains and snows through March and April until its inception. Considerable standing timber was blown down in the northern Cascade Range and the forests of the State were littered with broken twigs and other debris, creating a humidities are also consistently of longer duration at the higher levels than at the lower levels at these times, because air circulates more freely and there is less range in temperature at night at the higher levels on the ridges than at the lower levels in the valleys.

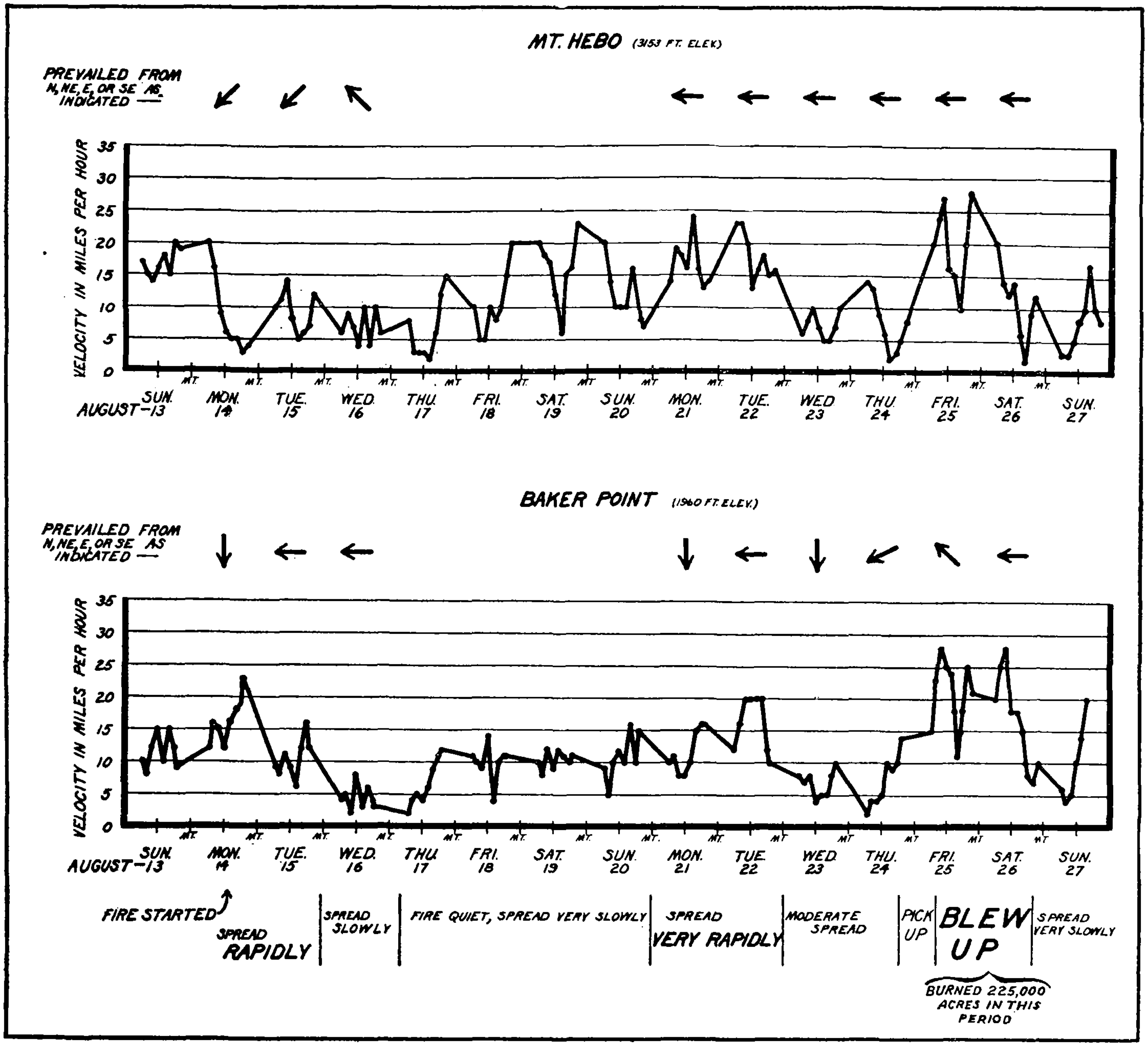

FIGURE 3.—Wind velocities and directions at stations nearest fire.

high potential fire hazard throughout the ensuing season. The fourth period and its attending results have already been discussed previously in this article. Winds increase normally in velocity with increasing altitude, but the highest winds in each of these critical periods were in the lower atmospheric levels up to 5,000 feet. Low relative

Other historic forest fires have occurred in western Oregon and the Pacific Northwest in the past, concerning which little is known aside from their location and size. There is little doubt in the mind of the writer, however, that the same meteorological factors, a combination of low relative humidities, easterly winds and high temperatures, so vital in the propagation of the Tillamook fire, were also big factors in the spread of these other large fires. Then, too, there were no organized agencies in those days for the prevention and suppression of forest fires, so it is likely they became much larger than would be possible under the efficient present-day methods for prevention and suppression. The weather in the northern Coast Range from August 21 to 26, particularly on the 25th and 26th, when the greatest damage was done in the Tillamook fire, was extremely bad and most likely as bad as any that had ever previously existed. Except for this one bad fire and the Wolf Creek fire, the protective organizations of Oregon and the Pacific Northwest enjoyed one of the best seasons in the history of organized protection in 1933.

Table 1.—*Highest daily wind velocity recorded at certain stations in northwestern Oregon during the 2 critical fire-weather periods in August 1933*

Stations	10th	11th	12th	13th	14th	15th	16th	21st	22d	23d	24th	25th	26th
North Head, Wash.[1]	28	27	26	26	22	20	17	18	20	15	16	17	18
Baker Point	12	17	20	15	23	16	6	16	25	10	14	30	28
Mount Hebo	11	14	24	20	20	14	10	24	25	13	14	28	20
Prairie Mountain	12	13	24	18	18	5	10	20	22	10	6	25	10
Portland[1]	11	13	15	15	13	11	9	15	17	8	10	19	16
Highland Butte	6	8	8	12	10	15	6	20	24	8	10	34	20
Green Peter	10	13	13	17	7	13	10	21	26	10	10	30	27
Mount Wilson[2]	16	20	21	20	19	23	19	36	39	22	34	43	31
Crown Point[3]	8	10	8	8	9	24	8	26	24	23	18	39	32

[1] Maximum wind during day, midnight to midnight, for period of 5 minutes.
[2] Highest average hourly velocity for day, midnight to midinight.
[3] 5 a.m. to 1 a.m.
Records at other sations are for daytime only, ranging from 6 or 7 a m. to 7 or 8 p.m.

Table 2.—*Departure of daily lowest relative humidities of 2-hour duration from the mean for August at the fire-weather stations nearest the Tillamook fire during the period the fire was most active in August 1933, also number of hours the relative humidity was below 35 percent for each of the 2 periods at each station*

	Mean	10th	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th	21st	22d	23d	24th	25th	26th	27th	Number of hours, 35 percent, and lower	
																				10–16	21–26
VALLEY STATIONS																					
Youngs River	56	0	−3	−14	−12	−27	−17	−9	-----	+2	+2	−5	−33	−35	−18	−8	−36	−29	+16	6	32
Jewell	50	−7	−7	−17	−20	−26	−22	−11	−11	−2	−5	−7	−28	−33	−33	−25	−34	−33	+26	18	47
Oregon-American	52	−18	−19	−22	−22	−28	−31	−12	−11	+3	+13	−5	-----	-----	-----	-----	-----	-----	-----	28	-----
Vernonia	44	−9	−11	−14	−15	−19	−25	−5	−1	+5	+14	−8	−19	−27	−24	−16	−27	−27	+24	29	52
Clark and Wilson	46	−6	−10	−11	−11	−17	−29	−9	−5	−4	+9	−10	−23	−28	−23	−19	−26	−26	+18	18	56
Forest Grove	40	−9	−12	−14	−17	−18	−17	−12	+7	0	+9	−7	−17	−18	+1	−11	−19	−18	+25	48	49
Portland	44	−9	−1	−12	−7	−8	−15	0	+15	+12	+6	+1	−9	−23	−20	−7	−25	−25	+23	14	52
Herman Creek R.S.	41	+8	+1	+4	+6	+3	−23	−8	+5	+5	+5	+6	−13	−18	−19	−21	−19	−20	+6	11	51
HIGH RIDGE STATIONS																					
Tidewater Tbr. Co.	53	−8	−10	−18	−17	−29	−23	−9	−6	+2	+5	−6	−33	−33	−30	−23	−29	−28	+24	15	69
C. H. Wheeler	48	−15	−18	−16	−17	−22	−23	−5	−3	+3	+15	−8	−23	−28	−28	−15	−22	−20	+23	38	88
Brix Logging Co.	51	−9	−10	−12	−14	−17	−25	+4	−19	+18	+8	+11	−23	−28	−23	−16	−26	−27	+15	10	83
Mount Hebo Lookout	58	−19	−11	−13	−23	−35	−32	−23	−28	+20	+24	+5	−31	−36	−35	−23	−33	−37	+2	87	136
Black Rock Camp	47	−4	−12	−14	−16	−19	−11	−15	−7	+3	+3	−11	−17	−22	−17	−11	−17	−19	+11	36	65
Green Peter Lookout	49	−22	−26	−40	−29	−30	−33	−23	−6	−3	+21	−3	−25	−34	−29	−19	−35	−27	−1	66	114
Mount Wilson Lookout	42	−13	−21	−24	−22	−21	−20	−22	−12	+5	+42	+18	−8	−11	−19	−10	−7	−8	−19	120	32
COAST STATIONS																					
Nehalem	64	−7	−15	−11	−10	−17	−5	+4	−6	+4	−3	−17	−51	−48	+8	+17	+8	−9	+18	7	20
Hebo	62	+10	+2	+1	+5	−12	−5	+3	+8	+6	−7	−9	−24	−40	+20	+13	−32	+4	+14	2	23

LONG-PERIOD FLUCTUATIONS OF SOME METEOROLOGICAL ELEMENTS IN RELATION TO CALIFORNIA FOREST-FIRE PROBLEMS

By Leslie G. Gray

[Weather Bureau Office, San Francisco, Calif., June 1934]

Weather is a very important factor in the starting and spreading of forest fires (1) (2) (3). Each weather element affects fire behavior in different ways of varying importance. At present, the forester takes advantage of short-period daily, day-to-day, and seasonal weather changes in carrying on his work of fire prevention and suppression, and is further aided by short-range forecasts by meteorologists. However, the forester is handicapped in planning a long-period forest protection policy, budgets, and administration by lack of foreknowledge of long-period weather sequences—ignorance as to what to expect from trends of given types and to what extent long-period fluctuations in specific weather factors have affected or will affect his fire problems. The purpose of this paper is to present in a preliminary way the facts obtained by an extensive compilation of California data, and to note the inferences drawn by various students of weather sequences, expressed in terms of the forester's fire problem. It should be emphasized here that this discussion deals with recorded data, and indicates furture prospects only to the extent that we may justifiably assume that the "before" and "after" pictures will be the same or similar.

The various weather factors are expressed as mean values for the State of California, using for each item a homogeneous body of data from selected stations. For comparison purposes, other hydrological and related data, mostly from other than Weather Bureau sources, are used as supporting evidence. The principal graphical method used for presenting the data is that of accumulated departures from normal or average, or residual mass curves, the computation and meaning of which are explained by Barnes (4) and Marvin (5). Briefly, accumulated departures are well adapted for showing secular sequences, trends, or changes without distortion of the actual data. The method accomplishes natural smoothing without obscuring the real values. Where the graph shows a rise, values have been above average; where it shows a fall, values have been below average; and where it is horizontal, values have been exactly average. E. H. Bowie visualizes accumulated departures as representing a sort of bank account between the State of California and nature.